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OPTIC SWITCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention generally relates to an optic switch, and more particular to an optic switch employing multiple reflections of optic signals to realizing switching of optic outputs.

2. The Related Arts

[0002] Optic switches are widely used in optic networks. The optic switches are usually classified as mechanical type and non-mechanical type. The mechanical type optic switch realizes switching operation between two or more outputs by moving optic fibers or optic elements with mechanical or electromagnetic means. Since an optic fiber is generally very thin, moving the optic fiber to switch between outputs is risky and may cause undesired loss of optic signals. On the other hand, moving an optic element, rather than a fiber, to perform switching operation is more advantageous. Such a method has only a cost of an insertion loss of less than 2 dB but gains a high isolation, sometimes as high as 45 dB. In addition, it is independent of polarization and wavelength of the incoming optic signals. The commonly used optic elements in such a switching device comprise reflectors, lenses, and prisms but not limited thereto, among which reflectors are the most common optic element that is moved to realize switching operation.

[0003] US Patent No. 5,042,889 teaches an optic switch that realizes switching operation by moving a reflector. Figures 1 and 2 of the attached

drawings illustrate an operation principle of the optic switch. Two optic inputs 130, 150 and two optic outputs 140, 160 are respectively aligned with each other forming two intersecting optic paths between the input and output 130, 140 and the input and output 150, 160 as shown in Figure 1. By placing a reflector 170 having opposite reflective surfaces 171, 172 (Figure 3 of the attached drawings) at the intersection of the optic paths, the input signal from the optic input 130 is reflected and redirected by the reflective surface 171 toward the optic output 160, while the input signals from the optic input 150 is reflected and redirected by the reflective surface 172 toward the optic output 140.

[0004] Since theoretically, the intersection of the optic paths is a single point, while the reflector that possesses two opposite reflective surfaces is always of a thickness, no matter how small it may be, between the reflective surfaces. As a consequence, only one of the reflective surfaces can be truly located at the intersection point to reflect and precisely redirect the input signals to the new output, while the other one is not. This is shown in the enlarged view of Figure 3 wherein the reflective surface 171 is exactly located at the intersection point so that the input signals from the input device 130 can be precisely redirected to the output device 160. However, the reflective surface 172 cannot be exactly located at the intersection point and the input signal from the optic input 150 is redirected to the optic output 140 along an offset and non-aligned path indicated by the dashed line shown in Figure 3. This causes a large signal loss.

[0005] It is desired to have an optic switch for overcoming the above problem.

SUMMARY OF THE INVENTION

[0006] Accordingly, an object of the present invention is to provide an optic switch, especially a 2x2 optic switch, that is capable to selectively and precisely redirect input signals from two optic inputs toward two optic outputs to realize optic switching operation without significant signal loss.

[0007] Another object of the present invention is to provide a mirror type optic switch comprising an additional reflective surface for precisely redirecting input signals to an optical output by means of multiple reflections.

[0008] To achieve the above objects, in accordance with the present invention, an optic switch includes a casing to which first and second input devices and first and second output devices are attached. The first input and output devices are aligned with each other and the second input and output devices are aligned with each other. A movable reflection device is movable between a non-engaged position and an engaged position between the input and output devices by a driving device. The movable reflection device has first and second reflective surfaces. A fixed reflection device is fixed inside the casing and has a third reflective surface which is parallel to and opposes the first reflective surface when the movable reflection device is at the engaged position. When the movable reflection device is at the non-engaged position, optic signals from the first and second input devices are allowed to directly pass to the first and second output devices respectively. When the movable reflection device is at the engaged position, the optic signal from the second input device is reflected and redirected by the second reflective surface to the first output device and the optic signal from the first input device is reflected at least three times by the first and third reflective surfaces and redirected to the second output device. Thus a switching operation is realized.

The instant application is essentially of a detailed embodiment of the copending application titled "OPTICAL SWITCH WITH MOVABLE MIRROR" filed Dec. 24, 2001 with an unknown serial number while having the same applicants and the same assignee as the invention. The basic principle of the instant invention is disclosed in such a copending application and should be referred thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will be apparent to those skilled in the art by reading the following description of a preferred embodiment thereof, with reference to the attached drawings, in which:

[0010] Figure 1 is a schematic view showing two optic paths in a conventional optic switch before a switching operation is taken;

[0011] Figure 2 is a schematic view showing the optic paths of the conventional optic switch after a switching operation is taken;

[0012] Figure 3 is an enlarged view of the encircled portion of Figure 2;

[0013] Figure 4 is a perspective of an optic switch constructed in accordance with the present invention, with a cover of the optic switch removed to show inside details;

[0014] Figure 5 is an exploded view of the optic switch of the present invention;

[0015] Figure 6 is a schematic view showing optic paths of the optic switch of the present invention after a switching operation is taken; and

[0016] Figure 7 is similar to Figure 6, but showing the condition before the switching operation is not taken.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] With reference to the drawings and in particular to Figures 4 and 5, an optic switch constructed in accordance with the present invention comprises a casing 10 and a cover 20 attached to the casing 10 to define a substantially sealed interior space therebetween for accommodating movable and fixed parts of the optic switch. The casing 10 is substantially rectangular and defines first, second, third, fourth holes 101, 102, 103, 104 in four corners thereof whereby the first and second holes 101, 102 are substantially aligned with each other and the third and fourth holes 103, 104 are substantially aligned to each other

[0018] First and second optic input devices 30, 50 are respectively mounted to the casing 10 through the first and third holes 101, 103 and first and second optic output devices 40, 60 are respectively mounted to the casing 10 through the second and fourth holes 102, 104 whereby the first optic input device 30 is substantially aligned with the first optic output device 40 and the second optic input device 50 is substantially aligned with the second optic output device 60.

[0019] Two internal walls 105, 106 are formed inside the casing 10. Each internal wall 105, 106 comprises two branches (not labeled) forming a predetermined included angle therebetween. Bores 107, 108, 109, 110 are respectively defined in the branches of the internal walls 105, 106 whereby the bores 107, 108, 109, 110 are respectively aligned with the holes 101, 102, 103, 104 of the casing 10. The internal walls 105, 106 also serve as structural reinforcement of the casing 10.

[0020] Each of the optic input and output devices 30, 40, 50, 60 comprises a fiber 31 (first input fiber), 41 (first output fiber), 51 (second input fiber), 61 (second output fiber) attached to a capillary 32, 42, 52, 62 and a collimating lens 33, 43, 53, 63 attached to an end of the capillary 32, 42, 52, 62. The collimating lenses 33, 43, 53, 63 can be GRIN lens attached to the capillaries 32, 42, 52, 62 by epoxy based adhesives. The collimating lenses 33, 43, 53, 63 are respectively received and retained in the bores 107, 108, 109, 110 defined in the internal walls 105, 106 with the collimating lenses 33, 53 of the first and second input fibers 31, 41 precisely and respectively aligned with the collimating lenses 43, 63 of the first and second output fibers 41, 61 whereby a first optic path is formed between the first input fiber 31 of the first input device 30 and the first output fiber 41 of the first output device 40. Similarly, a second optic path is formed between the second input fiber 51 of the second input device 50 and the second output fiber 61 of the second output device 60, as shown in Figure 7. The optic paths intersect.

[0021] Each optic input/output device 30, 40, 50, 60 further comprises a securing member 34, 44, 54, 64 respectively attached to the first, second, third, fourth hole 101, 102, 103, 104 defined in the casing 10 to secure the first input fiber 31, the first output fiber 41, the second input fiber 51, the second output fiber 61 to the casing 10. A strain relief 35, 45, 55, 65 is attached to the securing member 34, 44, 54, 64 and encompasses the fiber 31, 41, 51, 61 for protection purposes. Thus, each fiber 31, 41, 51, 61 extends through the strain relief 35, 45, 55, 65 and the hole 101, 102, 103, 104 of the casing 10 with an end thereof attached to the capillary 32, 42, 52, 62.

[0022] A fixed reflection device 80 and a movable reflection device 70 are encased in the casing 10 and are selectively positioned at the intersection between the first and second optic paths between the first pair of input and output devices

30, 40 and between the second pair of input and out devices 50, 60 to switch optic paths between the first and second output devices 40, 60 as shown in Figure 6.

[0023] The movable reflection device 70 comprises reflectors having first and second reflective surfaces 71, 72 and fixed in a retainer 911. Preferably, the first and second reflective surfaces 71, 72 are parallel to each other. An arm 91 extends from the retainer 911 and is coupled to a driving device 90 for moving the movable reflection device 70 into/out of the optic paths between the input devices 30, 50 and the output devices 40, 60. The driving device 90 may be any known means, such as relay and solenoid. The movable reflection device 70 is, thus, movable between an engaged position (Figure 6) and a non-engaged position (Figure 7). A stop 912 is formed inside the casing 10 for stopping the movement of the movable reflection device 70 from the non-engaged position to the engaged position so as to precisely position the movable reflection device 70 in the engaged position.

[0024] The fixed reflection device 80 comprises a holder 82 defining a recess 821 for receiving and retaining a reflector that forms a third reflective surface 81. The holder 82 is received and retained in a recess 12 defined in a bottom (not labeled) of the casing 10 whereby the third reflective surface 81 is parallel to and opposing the first reflective surface 71 of the movable reflection device 70. The recess 12 is located to position the fixed reflection device 80 out of the optic paths between the input and output devices 30, 40, 50, 60 whereby no direct interference with the optic paths can be caused.

[0025] Preferably, the first, second and third reflective surfaces 71, 72, 81 are made with high reflectivity material, such as zinc sulfide. Preferably, the reflective surfaces 71, 72, 81 are coatings of the high reflectivity material.

[0026] Referring to Figure 7, when the movable reflection device 70 is located at the non-engaged position, optic signals coming from the first and second input devices 30, 50 are not blocked or reflected by any of the reflective surfaces 71, 72, 81 and are thus allowed to pass directly to the corresponding first and second output devices 40, 60.

[0027] Referring to Figure 6, when the movable reflection device 70 is moved to the engaged position, the second reflective surface 72 is exactly located at the intersection of the first and second optic paths thereby precisely reflecting the optic signal coming from the second input device 50 to the first output device 40, while the optic signals coming from the first input device 30 is reflected by the first reflective surface 71 to the third reflective surface 81 of the fixed reflection device 80 and then returned by the third reflective surface 81 to the first reflective surface 71 where the optic signal is reflected again by the first reflective surface 71 to the second output device 60. The optic paths are thus switched.

[0028] With the aid of the third reflective surface 81 of the fixed reflection device 80, the first reflective surface 71 does not need to be precisely located at the intersection of the optic paths and neither being necessarily coincident with the second reflective surface 72.

[0029] It is apparent to those skilled in the art to attach the third reflective surface 81 to the movable reflection device 70 whereby the third reflective surface 81 moves in unison with the movable reflection device 70 between the engaged position and the non-engaged position. Other modification of the present invention may also be apparent to those skilled in the art, such as changing the shape and size of the reflective surfaces 71, 72, 81 of the fixed and movable reflection devices 70, 80.

[0030] Although the present invention has been described with reference to the preferred embodiment thereof, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from the scope of the present invention which is intended to be defined by the appended claims.